Chapter 10

Hand: Carpals, Metacarpals, and Phalanges

The hand is a complex structure that represents the tetrapod's distal limb segment. It is the modified end of the ancestral fish fin, a structure based on jointed bony rays. In the generalized reptilian hand, a set of small wrist bones (carpals) forms the foundation for five digits. Each digit is composed of one large proximal segment (a metacarpal) and a chain of additional bones (the phalanges). Digital reduction and modification have occurred in a great variety of mammals, from the wings of bats to the single toes of modern horses. Humans have retained the generalized pattern of five digits. There are a total of 27 bones in each human hand, eight carpal bones arranged in two rows, followed distally by a single row of five metacarpals. Farther distally, there is a single row of five proximal phalanges, a single row of four intermediate phalanges, and a single row of five distal, or terminal, phalanges.

In addition to the 27 major hand bones, there are small bones called **sesamoid bones** that lie within tendons of the hand. These are not usually recovered and are rarely studied by osteologists, who should nevertheless always be alert to their presence as they are of considerable functional significance. In the hand, a pair of sesamoids is usually found on the palmar aspect of the first metacarpal head. Figures 10.1–10.3 summarize and illustrate articulations within the hand.

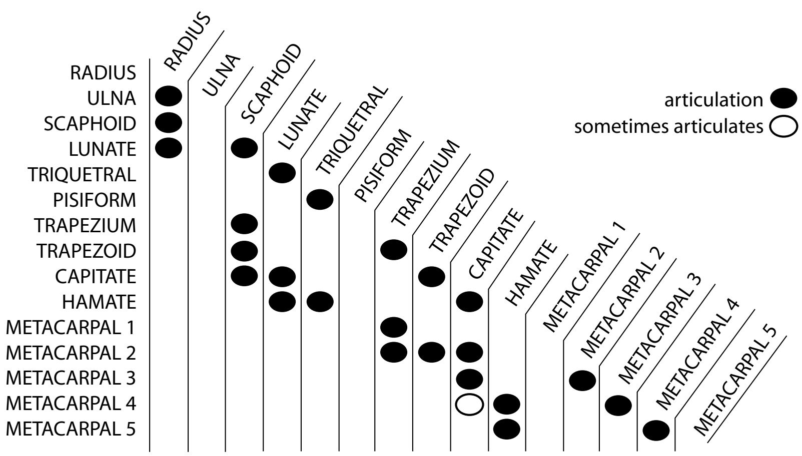

Figure 10.1 **Articulation of bones in the adult human wrist and hand.**

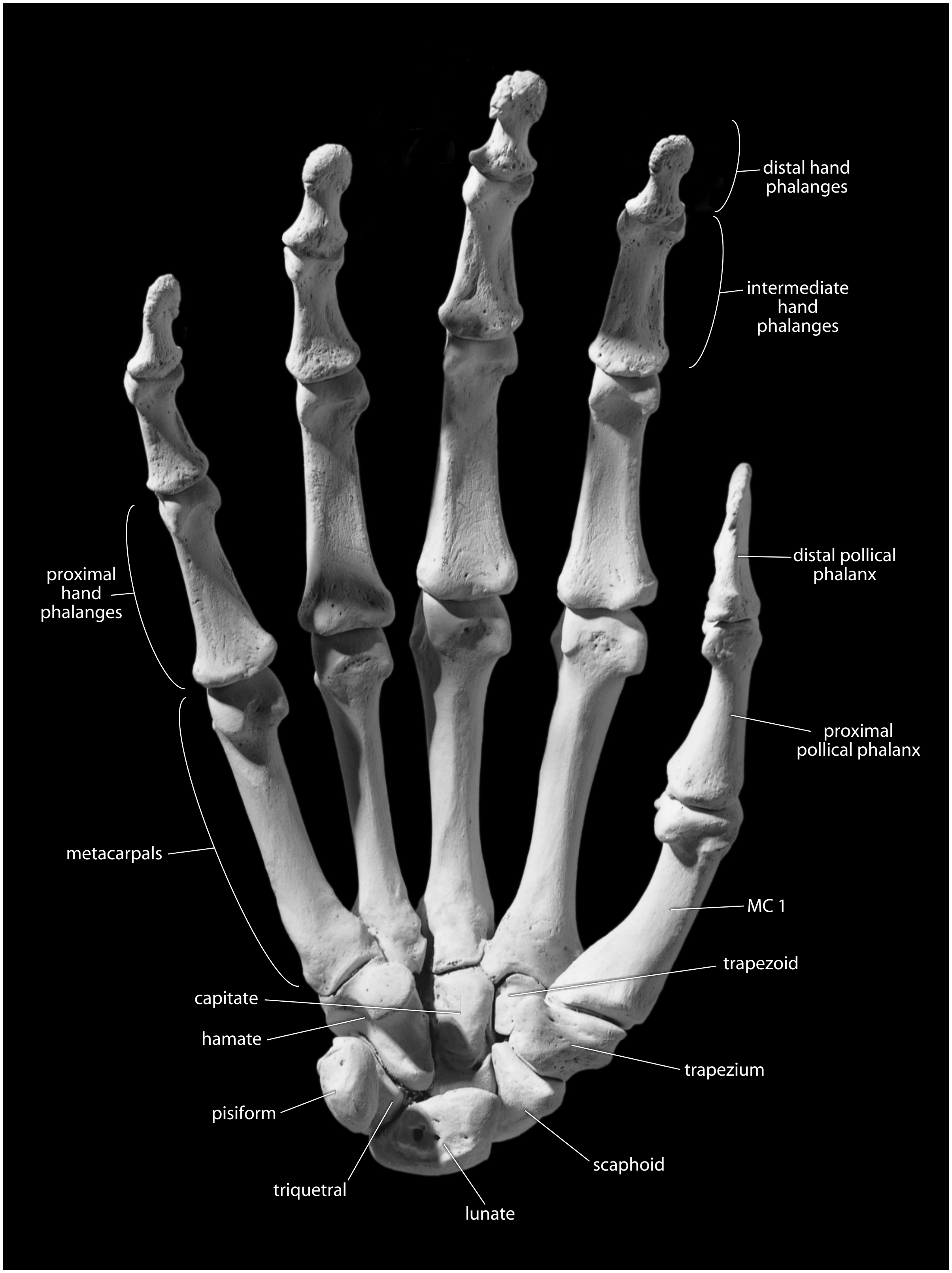

Figure 10.2 **Right hand, palmar** (**anterior**). Small sesamoid bones not included. Natural size.

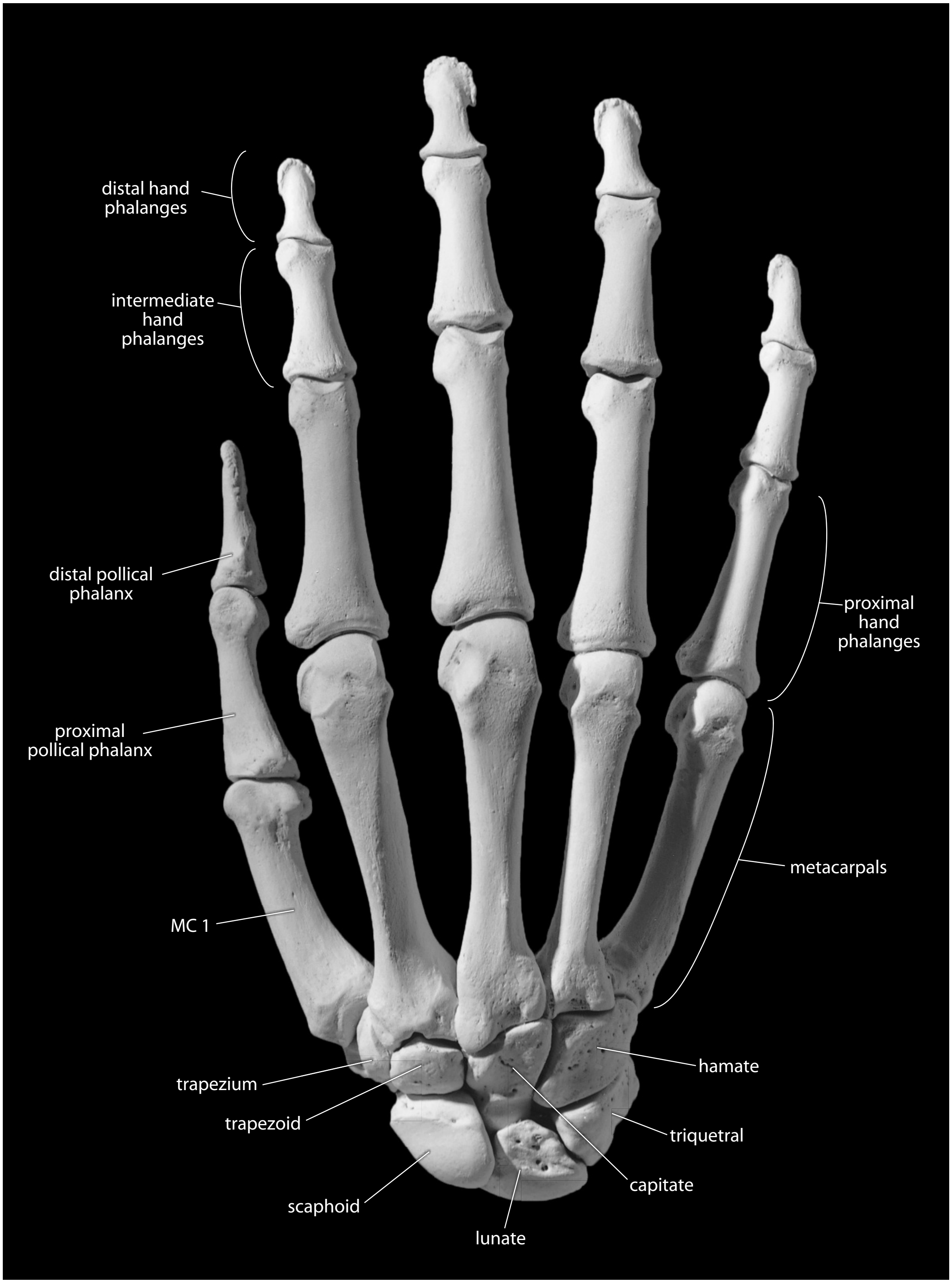

Figure 10.3 **Right hand, dorsal** (**posterior**). Small sesamoid bones not included. Natural size.

Elements of the hand skeleton are described in three categories: the **carpals**, the **metacarpals**, and the **hand phalanges**. In the carpal region of the hand, as in the tarsal region of the foot, a variety of different names have been applied to each bone as anatomical nomenclature has evolved through the years. For readers curious about this history, O'Rahilly (1989) provides a good summary.

Before analyzing the various elements that make up the hand, it is useful to note the importance of anatomical nomenclature in the study of the hand. In dealing with elements of the hand, it is easy to become confused by the terms "anterior," "posterior," "medial," and "lateral" because these terms can only be applied when the specimen is in standard anatomical position. For this reason, it is useful to supplement the directional terms when possible, using the following sets of synonyms:

- anterior = palmar
- posterior = dorsal
- medial = ulnar = little finger side
- lateral = radial = thumb side

The term **ray** is often applied to each finger, or toe, including the phalanges and metacarpal of the digit. By convention, the thumb ray, or **pollex**, is identified as ray number 1. The index finger is ray 2, the middle finger is ray 3, the ring finger is ray 4, and the little finger is ray 5.

10.1 Carpals (Figures 10.4–10.11)

The eight bones of the adult wrist are often described as cubical in shape with six surfaces, but this is a misleading characterization. Each bone has a unique, diagnostic shape. For this reason, identification is straightforward. An introduction to the functional anatomy of the wrist facilitates study of the individual wrist elements. The palmar surface of the carpus, or wrist, bears four major projections. The hook of the hamate and the pisiform underlie the medial edge of the palm at the base of metacarpal 5 (MC 5). The scaphoid tubercle and crest of the trapezium underlie the lateral edge of the palm, at the base of the thumb, or pollical, metacarpal (MC 1). In life there is a fibrous band stretched transversely between these carpal elevations. This band, the *flexor retinaculum*, creates a **carpal tunnel** through which *flexor tendons* of the wrist pass.

The carpals are divided into a proximal row incorporating (from radial to ulnar) the **scaphoid**, the **lunate**, the **triquetral**, and the **pisiform**. The scaphoid and lunate both articulate with the radius. The distal row of carpals, again from radial to ulnar, is composed of the **trapezium** (or **greater multangular**), the **trapezoid** (or **lesser multangular**), the **capitate**, and the **hamate**.

10.1.1 Scaphoid (Figure 10.4)

The scaphoid bone (also known as the hand navicular) is shaped like a boat, and is one of the largest carpal bones. It is the most lateral and proximal carpal, interposed between the radius and the trapezium, at the base of the thumb.

a. The **scaphoid tubercle** is a blunt, nonarticular projection adjacent to the hollowed capitate facet on the lateral edge of the bone. The tubercle is one of four attachment points for the *flexor retinaculum*, a fibrous band across the wrist.
b. The **facet for the head of the capitate** is the large concave facet on the proximal side of the scaphoid.
c. The crescent-shaped **facet for the lunate** is also on the proximal side of the scaphoid, but is on the medial edge of the bone.

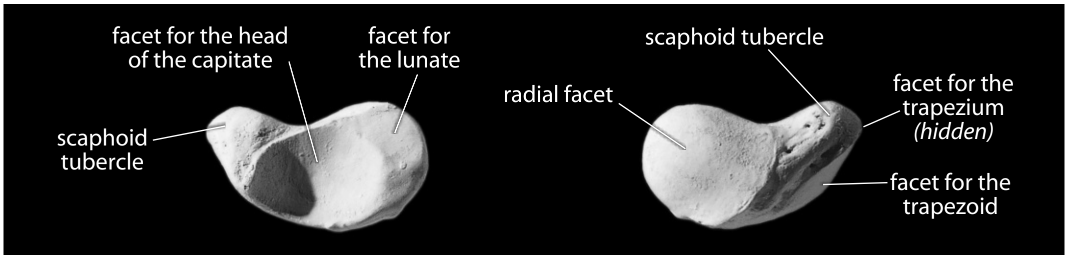

Figure 10.4 **Right scaphoid. Palmar is up.** *Left:* view from the capitate; *right:* view from the radius. Natural size.

d. The **radial facet** is the single, convex facet on the distal end of the scaphoid.
e. The **facet for the trapezoid** runs along the dorsolateral edge of the bone towards the tubercle.
f. The **facet for the trapezium** is found at the lateral end of the dorsal side of the bone.

- **Anatomical siding:** The facet for the head of the capitate is distal. The scaphoid tubercle is on the palmar surface and is lateral (toward the thumb).
- **Positional siding:** Hold the scaphoid with the facet for the capitate facing you and the tubercle pointed up. The tubercle leans toward the side from which the bone comes.

10.1.2 Lunate (Figure 10.5)

The lunate has a shape that recalls the form of a crescent moon. The deeply concave surface articulates with the capitate, and the large, broad articulation opposite this shares the distal radial articular surface with the scaphoid. The lunate has five distinct articular facets:

a. The **facet for the radius** is the large, convex articular surface that covers much of the proximomedial surface.
b. The **facet for the scaphoid** is crescent-shaped and found on the proximolateral surface.
c. The deeply concave **facet for the head of the capitate** is adjacent to the scaphoid facet, and is the most lateral of the three remaining facets spanning the distal surface.
d. The **facet for the triquetral** is somewhat triangular, tapering as it nears the medial tip of the bone.

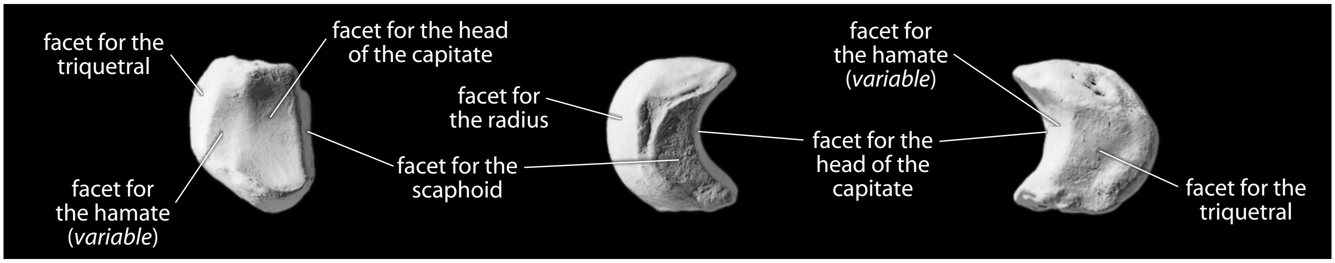

Figure 10.5 **Right lunate.** *Left:* view from the capitate; dorsal is up. *Middle:* view from the scaphoid, palmar is up. *Right:* view from the triquetral, palmar is up. Natural size.

e. The **facet for the hamate** is the smallest distal facet, and it separates the other two facets.

- **Anatomical siding:** The facet for the radius is proximal, and the facet for the capitate is distal. The long, narrow facet for the scaphoid is lateral (on the thumb side). The remaining facet, for the triquetral, is displaced dorsally. The largest nonarticular surface is palmar.
- **Positional siding:** Position the lunate with concave facet for the capitate facing you and the flat nonarticular surface kept horizontal. The tapering medial end will point up and will be leaning towards the side from which the bone comes.

10.1.3 Triquetral (Figure 10.6)

The triquetral is the third bone from the thumb side in the proximal carpal row. It has three main articular surfaces (hence its name):

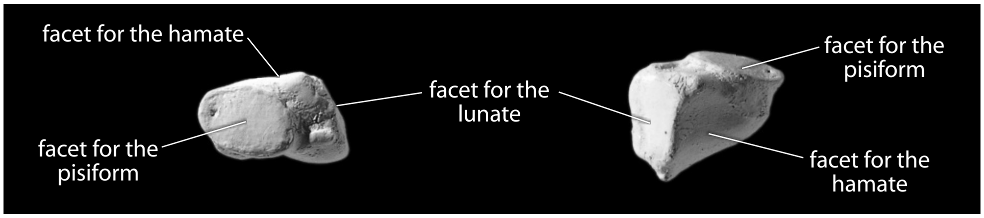

Figure 10.6 **Right triquetral.** *Left:* palmar view; lateral is up. *Right:* view from the hamate; palmar is up. Natural size.

a. The **facet for the hamate** is the largest facet and is located distally.
b. The **facet for the lunate** is lateral to, but continuous with, the facet for the hamate.
c. The distinctive **facet for the pisiform** is the single, circular, isolated, and elevated facet. It is the smallest of the three facets, located on the palmar, medial surface of the bone.

- **Anatomical siding:** The facet for the pisiform is palmar and medial. The facet for the hamate is distal. The lunate facet is lateral to, but continuous with, this facet.
- **Positional siding:** Hold the common edge between the two largest facets toward you and oriented vertically. When the facet for the pisiform faces up, it points toward the side from which the bone comes.

10.1.4 Pisiform (Figure 10.7)

The pisiform bone is pea-shaped, with one side flattened by the triquetral articular facet. The pisiform is the smallest of the carpals. Because it develops within a tendon, it is actually a sesamoid bone. There are other, much smaller sesamoid bones found embedded in flexor tendons, for example, at some metacarpophalangeal and interphalangeal joints.

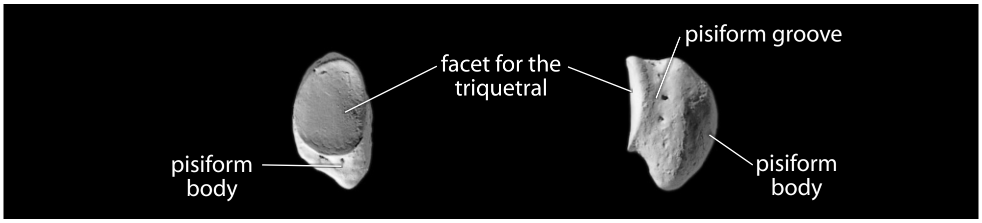

Figure 10.7 **Right pisiform.** *Left:* view from the triquetral; distal is down. *Right:* view from the proximal, palmar hamate end; the triquetral facet is up and faces the left (dorsal). Natural size.

a. The nonarticular **pisiform body** is one of the four attachment points for the *flexor retinaculum.*
b. The single, ovoid **facet for the triquetral** is on the dorsal side of the bone.
c. The **pisiform groove** runs between the body and the facet on the radial side of the bone.

- **Anatomical siding:** The nonarticular body of the pisiform underlies the ulnar corner of the base of the palm. *Note:* The morphological variation of this bone makes siding accurate in only about 85–90% of all cases; the bone illustrated in Figure 10.7 is an example of a bone for which this siding method will *not* work.
- **Positional siding:** Hold the facet toward you and turn the bone until the bulk of the nonarticular surface that is visible in this view is up. The groove and the bulk of this visible surface is displaced toward the side from which the bone comes. *Note:* the bone illustrated in Figure 10.7 is an example of a bone for which this siding method will *not* work.

10.1.5 Trapezium (Figure 10.8)

The trapezium (sometimes called the greater multangular) is an irregularly sided bone of medium size. It is distinguished by its largest facet, a saddle-shaped articular surface for the base of MC 1 (thumb), and by a long, raised, narrow tubercle, or crest.

a. The **trapezial ridge** (formerly the **crest** or **tubercle**) is the elongate, proximodistally oriented projection on the palmar surface. This crest serves as an attachment point for the *flexor retinaculum.*
b. The **trapezial groove** is on the medial side of the crest and houses the *tendon of the flexor carpi radialis muscle.*
c. The sellar **facet for MC 1** is the largest facet on the bone.
d. The **facet for MC 2** is a small facet found on the distal apex of the trapezium.
e. The **facet for the trapezoid** is found on the medial side of the bone, sandwiched between the facet for MC 2 and the facet for the scaphoid.
f. The **facet for the scaphoid** is the most proximal facet on the bone, often appearing continuous with the facet for the trapezoid.

- **Anatomical siding:** The trapezial ridge is palmar. The groove adjacent to this tubercle is medial (toward the center of the hand). The sellar facet for MC 1 is distal and faces laterally.
- **Positional siding:** Place the bone on a flat surface with the tubercle on top and away from you, and the concave facets on either side. The groove adjacent to the tubercle is on the side from which the bone comes.

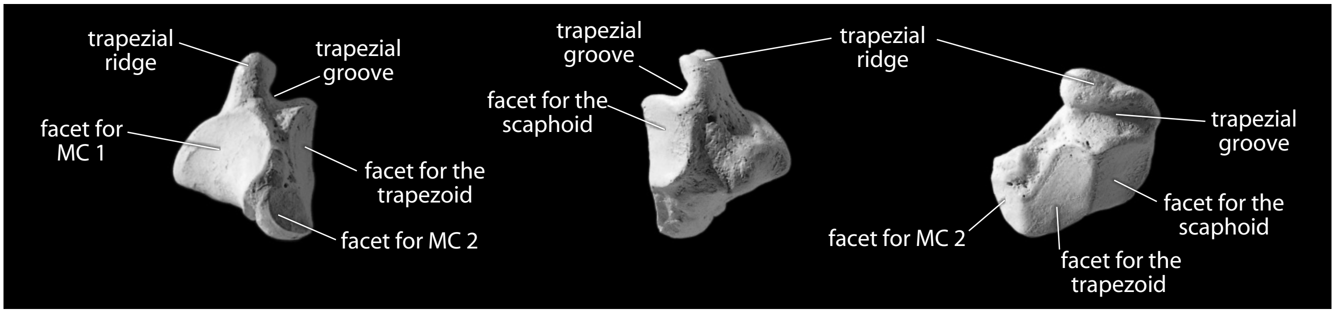

Figure 10.8 **Right trapezium.** *Left:* view from the MC 2 base; palmar is up. *Middle:* view from the lateral scaphoid end. *Right:* view from the scaphoid-trapezoid boundary (from medial), distal is to the right. Natural size.

10.1.6 Trapezoid (Figure 10.9)

The trapezoid (sometimes called the lesser multangular) is boot-shaped and is the smallest carpal bone in the distal row. It articulates distally (via a double facet) with the base of MC 2. The trapezoid has four articular surfaces and two nonarticular surfaces:

a. The **double facet for MC 2** is the pair of convex articular surfaces on the distolateral side of the bone. If you imagine the trapezium as a boot, the double facet would extend from the laces to the toes.
b. The **facet for the capitate** is also a large facet on the distal end of the bone, but this facet is on the distomedial aspect of the trapezoid.
c. The **nonarticular palmar surface** spills onto the lateral surface of the bone and tapers dorsally to a V-shaped cleft that separates the facets for the trapezium and MC 2. This would be the opening and side zipper of the boot.
d. The **facet for the trapezium** is proximal to the adjacent V-shaped cleft.
e. The **facet for the scaphoid** is the somewhat excavated facet on the medial surface, opposite the V-shaped cleft. The sharp ridge between this facet and the facet for the trapezium forms the back of the heel of the boot.
f. The **nonarticular dorsal surface** is the large, flat area that would be the sole of the boot.

- **Anatomical siding:** The largest nonarticular surface is dorsal, and its most pointed corner is proximal and lateral (on the thumb side). Just palmar to this corner there is a sharp ridge where the lateral, more convex articular facet for the trapezium meets the proximal, more concave articular facet for the scaphoid.
- **Positional siding:** Place the "sole" of the boot on the table, with the narrow, V-shaped cleft facing you. The toe of the boot then points toward the side from which the bone comes.

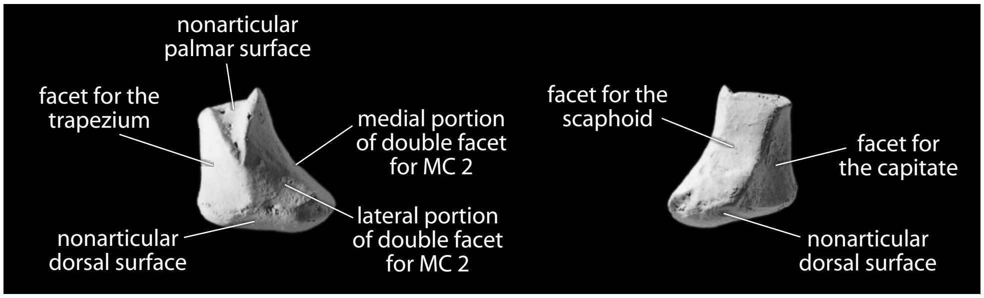

Figure 10.9 **Right trapezoid.** *Left:* view from the distalmost trapezium; palmar is up. *Right:* view from the capitate-scaphoid boundary (from proximal). Natural size.

10.1.7 Capitate (Figure 10.10)

The capitate is a large carpal bone that articulates distally with the bases of MC 3, MC 2, and (sometimes) MC 4. Its distal end is therefore squared off, while the proximal end is rounded.

a. The **head** of the capitate is the rounded end of the bone that articulates proximally with the hollow formed by the lunate and scaphoid.
b. The **base** of the capitate is the more squared-off end that articulates distally most directly with the base of MC 3.

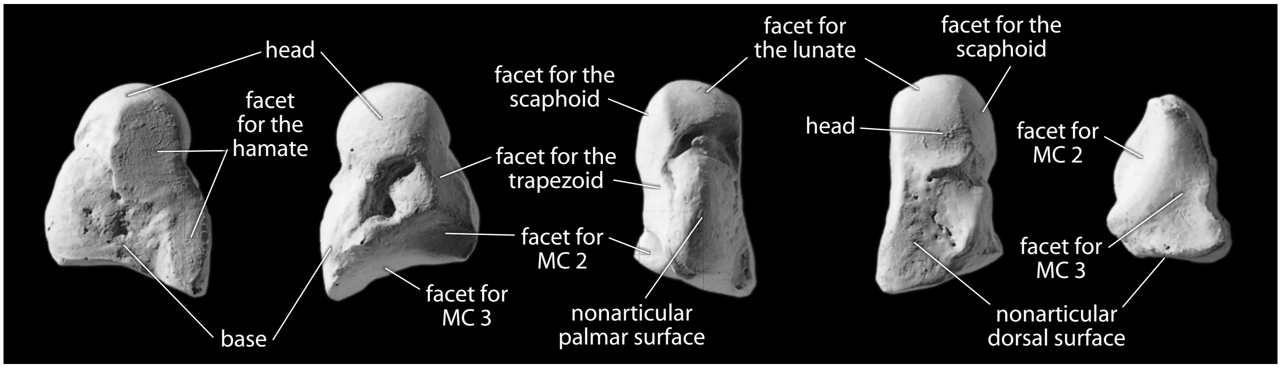

Figure 10.10 **Right capitate.** *All but right:* proximal is up; *right:* palmar is up. *From left:* medial view; lateral view; palmar view; dorsal view; distal view. Natural size.

c. On the medial side of the head is a large, flat-to-concave facet, the **facet for the hamate**. Towards the base this facet is highly variable; it may extend all the way to the base or only halfway, and it may be a single facet or multiple facets.
d. The **facet for the scaphoid** is found on the lateral side of the head and may appear continuous with the **facet for the lunate**, which occupies the central portion of the head.
e. The **facet for MC 3** dominates the base of the capitate.
f. The **facet for MC 2** truncates the medial edge of the base of the capitate.
g. The **facet for the trapezoid** extends onto the medial side of the capitate from the base and reaches for the head. Like the hamate facet, this facet is highly variable in its extent.
h. The **nonarticular palmar surface** is thin and crest-like.
i. The **nonarticular dorsal surface** is the largest, flattest nonarticular surface.

- **Anatomical siding:** Proximally the head articulates in the hollow formed by the lunate and scaphoid. The largest, flattest nonarticular surface is dorsal. The more concave surface of the head is for the hamate and is thus medial (on the little finger side).
- **Positional siding:** With the head pointing up and the base resting on the table, place the long, narrow hamate facet toward you. This articulation is on the side from which the bone comes.

10.1.8 Hamate (Figure 10.11)

The hamate is the wedge-shaped carpal bone with the **hamulus**, the hook-shaped, nonarticular projection on the palmar surface. This hamulus is one of four attachment points for the *flexor retinaculum*. The hamate has five distinct articular facets:

a. The **facet for MC 5** is immediately beneath (dorsal to) the hamulus, and is one of two facets on the **base** of the hamulus.
b. The **facet for MC 4** is on the medial side of the base, adjacent to the facet for MC 5.
c. The **facet for the triquetral** is the longest facet on the hamate, extending from the proximal **apex** nearly all the way to the base.
d. The **facet for the capitate** is the oval articular surface on the medial side of the apex.
e. The **facet for the lunate** is variably present. When present, it is usually a narrow facet that truncates the proximal apex of the bone.

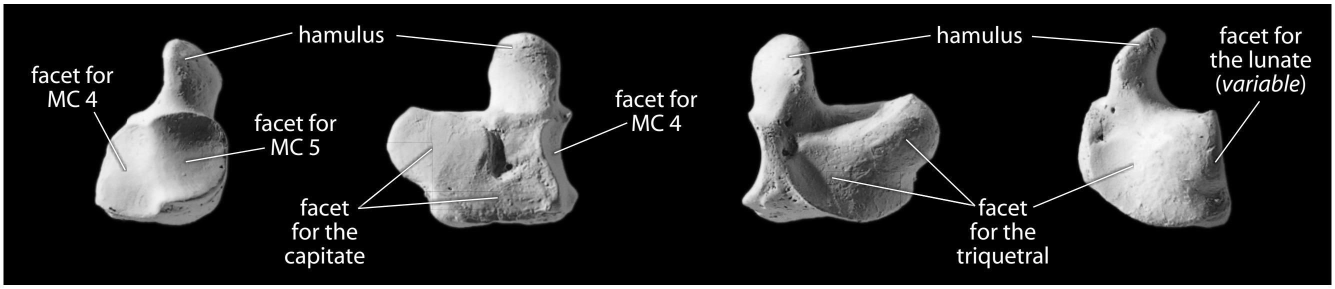

Figure 10.11 **Right hamate.** Palmar is up. *From left:* distal view; lateral view; medial view; proximal view. Natural size.

- **Anatomical siding:** The bone articulates distally with the bases of MC 4 and MC 5 via a double facet at the base of the hamulus. The hamulus is placed on the distal, palmar surface of the bone and is medial, hooking over the edge of the carpal tunnel in this position.
- **Positional siding:** Place the flat, nonarticular surface down with the hook and the two adjacent metacarpal facets away from you. The hook leans toward the side from which the bone comes.

10.1.9 Growth

The carpal bones each ossify from a single center.

10.1.10 Possible Confusion

Because of their small size and compact construction, the identification of fragmentary carpal bones is not usually called for. If the hand has been carefully collected, intact carpal bones are usually available. Each of these is distinctive and impossible to confuse with another. Confusion of the adult carpal bones with the tarsal bones is improbable because the former are all smaller than the latter and the shapes are all distinctive.

Many skeletons, especially those from archaeological contexts, have incomplete hands because of postmortem disturbance of the skeleton (for instance, burrowing rodents) before excavation. These animals often move smaller skeletal elements during their burrowing activities. During archaeological excavation, very small bones, such as the sesamoids, pisiform, and terminal phalanges, may be inadvertently lost if care and fine screening are not employed in recovery.

10.1.11 Carpal Measurements

There are several standard measurements for each carpal, but these are rarely used by anyone other than specialists in carpal anatomy (see Martin 1928: 1022–1030, for example).

10.1.12 Carpal Nonmetric Traits

- Supernumerary, or accessory, carpal bones occasionally form in the wrist. Several of these variants occur frequently enough to warrant specific names: the **os centrale**, **os epitriquetrum**, **os hypotriquetrum**, **os styloideum**, and **os triangulare** are the most common.

10.2 Metacarpals (Figures 10.12–10.18)

The metacarpals are numbered MC 1 (the thumb) through MC 5 (the little finger), according to the five rays of the hand. They are all tubular bones, with round distal articular surfaces (**heads**) and more rectangular proximal ends (**bases**). They are identified and sided most effectively according to the morphology of the bases.

The bases of the metacarpals articulate with their neighbors in positions 2–5. All four of the carpals in the distal row articulate with one or more metacarpal bases: the trapezium with MC 1 and MC 2, the trapezoid with MC 2, the capitate with MC 2 and MC 3 (and sometimes MC 4), and the hamate with MC 4 and MC 5.

10.2.1 First Metacarpal (Thumb)

The first metacarpal is the shortest metacarpal, broader and more robust in its shaft than the others. Its single proximal articular surface is saddle-shaped, corresponding to the facet on the trapezium.

- **Siding:** The maximum palmar projection of the bone at the base is always toward the medial side. Therefore, in a proximal view, imagine dividing the saddle-shaped proximal facet into medial and lateral portions. The medial portion of the articular surface is always smaller. The lateral palmar surface of the shaft is larger and more excavated than the medial palmar surface. Viewed dorsally, with the distal end up, the axis of maximum length is skewed basally toward the side the bone is from.

10.2.2 Second Metacarpal

The second metacarpal is normally the longest metacarpal, at the base of the index finger. The base presents a long, curved, blade-like wedge that articulates with the trapezoid, capitate, trapezium, and MC 3.

- **Siding:** The most proximal part of the base is a broad, blade-like, medially positioned wedge that bears the articulation for MC 3.

10.2.3 Third Metacarpal

The third metacarpal lies at the base of the middle finger. It is the only metacarpal with a sharp projection, the **styloid process**, at its base. It articulates with the capitate and MC 2 and MC 4 at the base.

- **Siding:** The styloid process is on the lateral, or MC 2, side of the bone.

10.2.4 Fourth Metacarpal

The fourth metacarpal lies at the base of the ring finger and is shorter and more gracile than MC 2 or MC 3. It has a fairly square base with three or four articular facets. It articulates (at its base) with the capitate (sometimes), hamate, MC 3, and MC 5.

- **Siding:** The proximal and medial basal facets share a common, right-angle articular edge.

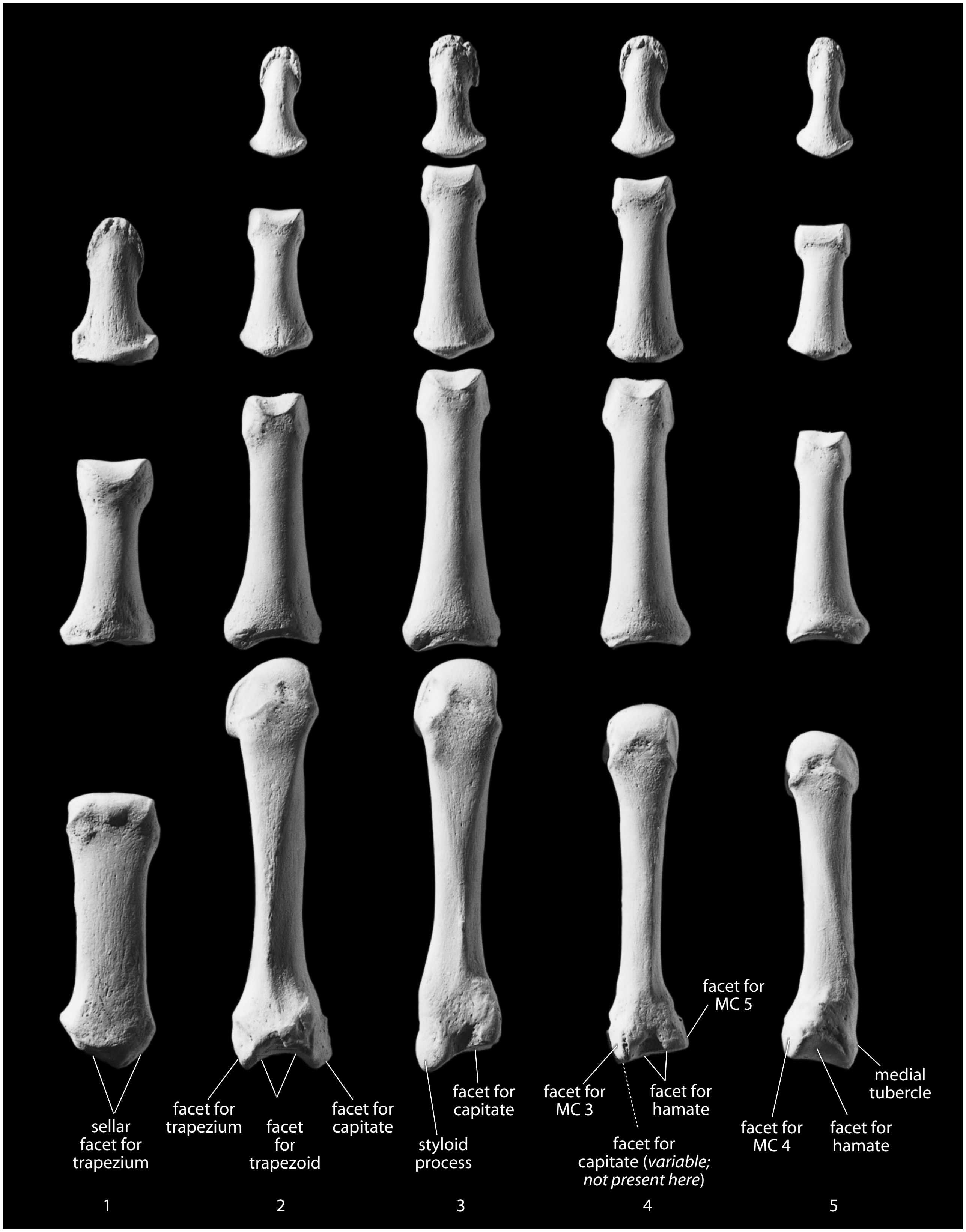

Figure 10.12 **Right hand, dorsal** (posterior). Rays 1–5, showing the metacarpals and the proximal, intermediate, and distal hand phalanges. Distal is up, lateral is toward the left. Natural size.

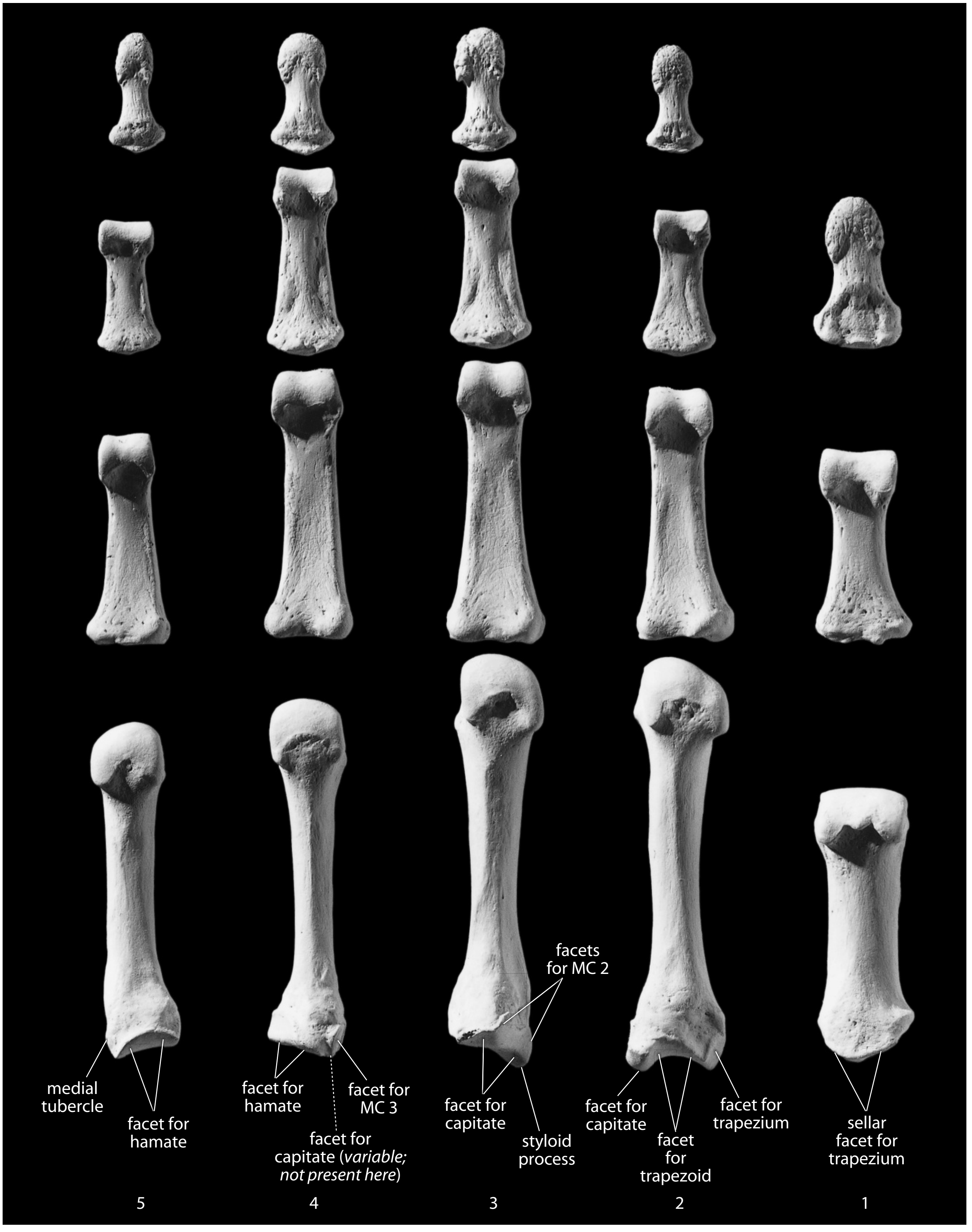

Figure 10.13 **Right hand, palmar** (anterior). Rays 1–5, showing the metacarpals and the proximal, intermediate, and distal hand phalanges. Distal is up, lateral is toward the right. Natural size.

Figure 10.14 **Right hand, lateral**. Rays 1–5, showing the metacarpals and the proximal, intermediate, and distal hand phalanges. Natural size.

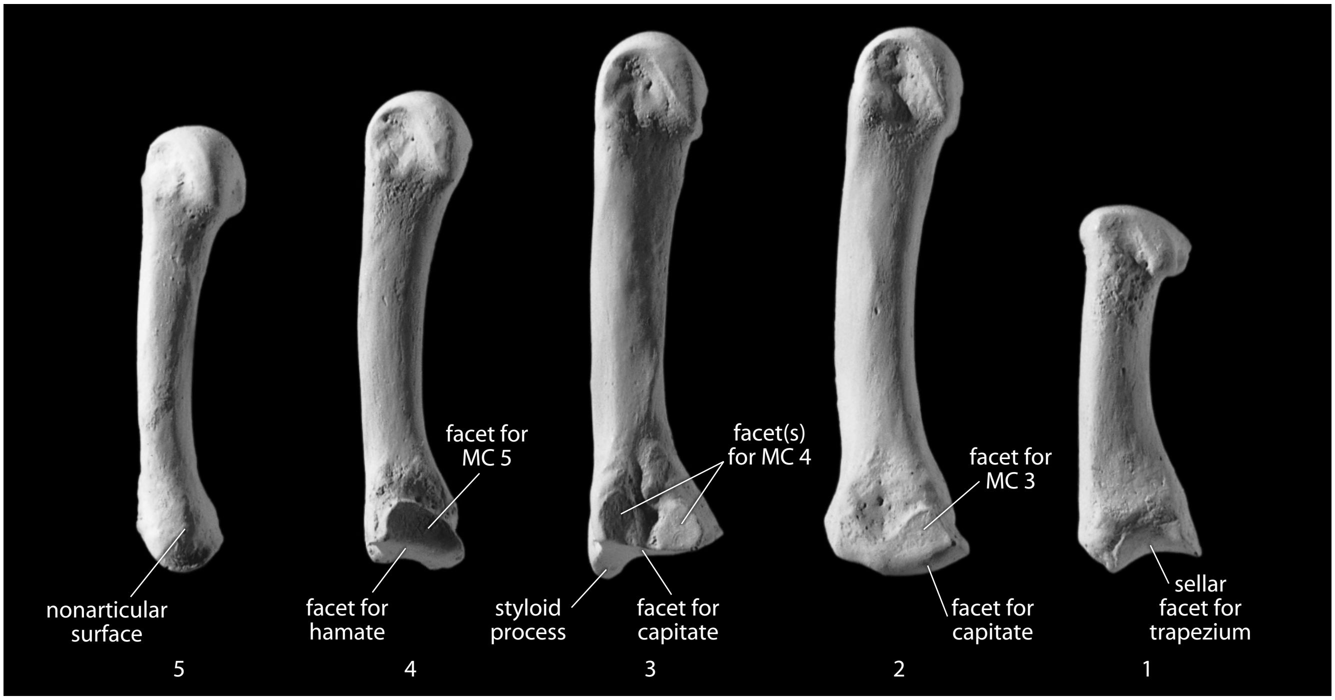

Figure 10.15 **Right metacarpals, medial.** Natural size.

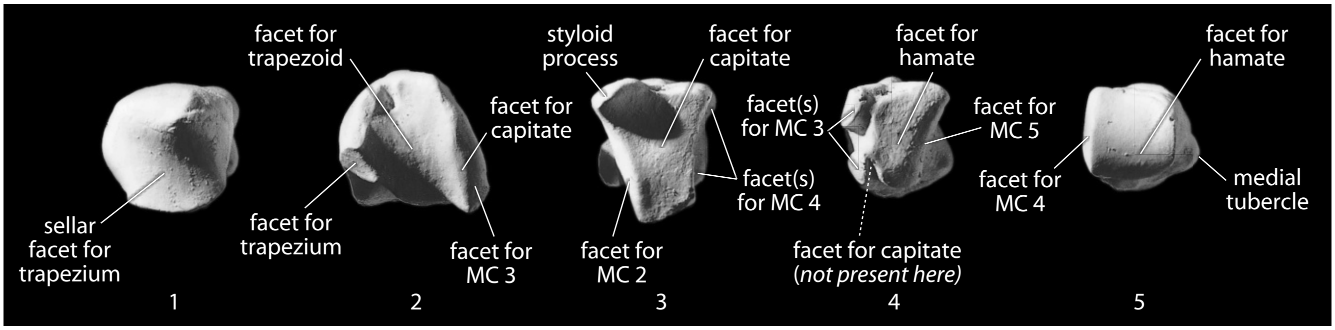

Figure 10.16 **Right metacarpal bases, proximal.** Dorsal is up, lateral is toward the left. Natural size.

10.2.5 Fifth Metacarpal

At the base of the little finger, the fifth metacarpal is the thinnest and shortest of the nonpollical metacarpals. It bears only two basal facets: one for the hamate and one for MC 4.

- **Siding:** The nonarticular side of the base faces medially, away from MC 4.

10.2.6 Growth (Figure 10.17)

Each metacarpal except MC 1 ossifies from two centers: a primary one for the shaft and the base, and a secondary one for the distal extremity (the head). The thumb metacarpal has a separate center for its base (but none for its distal extremity).

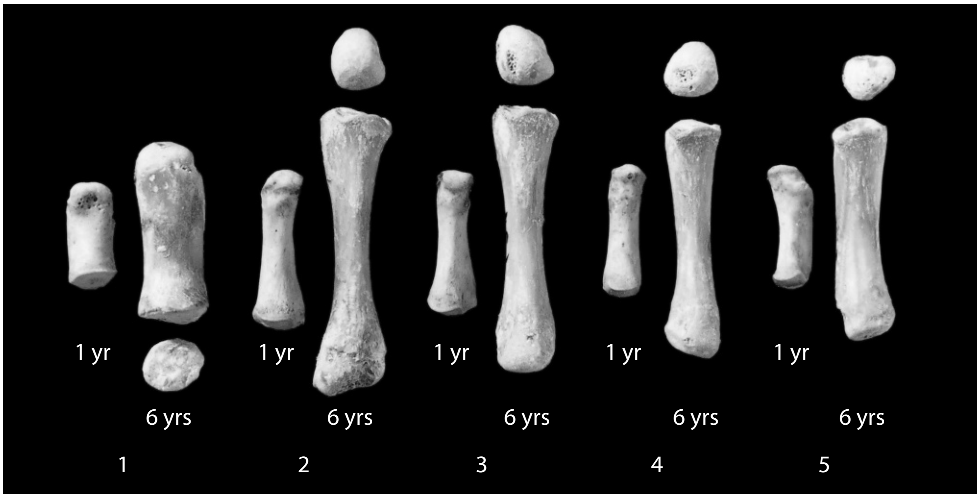

Figure 10.17 **Metacarpal growth**. The pairs of immature metacarpals are shown here in anterior (palmar) view, with ray 1 on the left and ray 5 on the right. They are from one-year-old and six-year-old individuals. Natural size.

10.2.7 Possible Confusion

Metacarpals 2–5 are stouter than metatarsals 2–5. Metacarpal shafts are larger in diameter relative to length and are not as straight and slender as metatarsal shafts. Metacarpal heads are more rounded than the mediolaterally compressed metatarsal heads.

10.2.8 Siding

In siding the metacarpals, the bases are always proximal, and the palmar shaft surfaces are always more concave than the dorsal surfaces in lateral view. Features of the base are used to side metacarpals as outlined in the preceding sections.

10.2.9 Metacarpal Measurements (Figure 10.18)

1. **Maximum metacarpal length** (Bush et al., 1983: 667, #1): With a sliding caliper kept parallel to the long axis of the diaphysis, determine the maximum length of the metacarpal.
2. **Metacarpal biomechanical** (or **articular**) **length** (Martin, 1928: 1031, #2): With a sliding caliper, measure the distance from the center of the carpal articular surface to the distalmost point on the metacarpal head.
3. **Midshaft dorsopalmar height** (Bush et al., 1983: 667, #7): First, determine the location at midshaft using 50% of biomechanical length. At this location, use a sliding caliper to measure the greatest dorsopalmar dimension.
4. **Midshaft mediolateral breadth** (Bush et al., 1983: 667, #6): Measuring from the midshaft location (50% of biomechanical length), use a sliding caliper to measure the greatest mediolateral dimension.

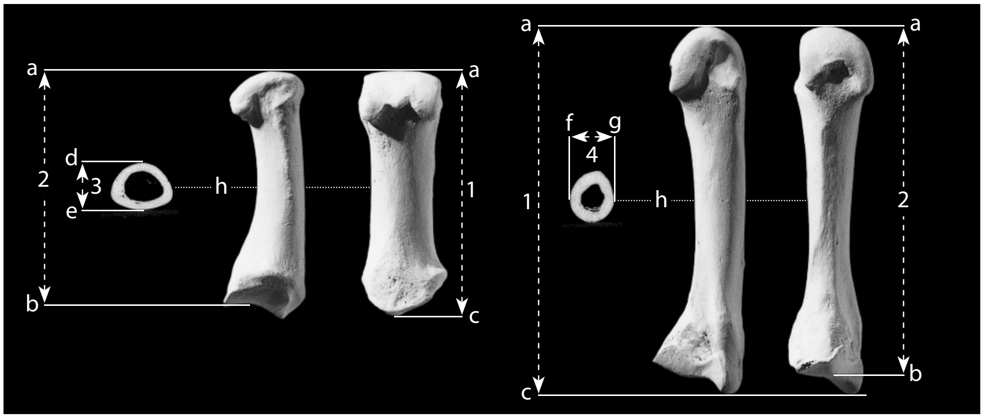

Figure 10.18 **Metacarpal measurements.** First and third metacarpals. Distal is up for bones; for scans, palmar is up. Two-thirds natural size.

Locations: a) distalmost point on metacarpal head; b) center of carpal articular surface; c) proximalmost point on metacarpal; d) palmarmost point at midshaft; e) dorsalmost point at midshaft; f) lateralmost point at midshaft; g) medialmost point at midshaft; h) location of midshaft.

Measurements: 1) maximum metacarpal length; 2) metacarpal biomechanical (or articular) length; 3) metacarpal midshaft height; 4) metacarpal midshaft breadth.

10.2.10 Metacarpal Nonmetric Traits

- No metacarpal nonmetric traits or significant anatomical variants have been noted for metacarpals.

10.3 Hand Phalanges (Figures 10.12–10.14, 10.19–10.21)

The hand phalanges are all shorter than metacarpals, lack rounded heads, and are anteroposteriorly flattened in their shafts. The pollical (thumb) phalanges are shorter and squatter than the others, and the pollex (thumb) lacks an intermediate phalanx. The expanded proximal end of each phalanx is the **base**. The distal end is the **head** (proximal or intermediate phalanges) or the **distal tip** (tuft; distal phalanges only). The distal articular surface of proximal and intermediate phalanges is called the **trochlea.** The nonarticular tubercles adjacent to the metacarpal heads and the phalangeal joints are attachment points for the *collateral ligaments*.

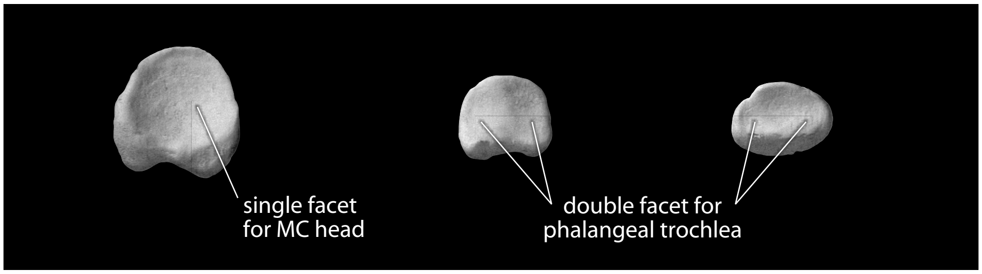

Figure 10.19 **Bases of hand phalanges.** *Left:* proximal hand phalanx; *center*: intermediate hand phalanx; *right:* distal (or terminal) hand phalanx. All phalanges are from ray 3. Dorsal is up. Natural size.

Dorsal surfaces of the hand phalanges are smooth and rounded. The palmar surfaces, in contrast, are flat and more roughened, especially along either side of the **shaft**, where raised ridges mark attachment sites for the *fibrous flexor sheaths*, tissues that prevent the *flexor tendons* from "bow stringing" away from the bones as the fingers are flexed.

10.3.1 Proximal Hand Phalanges

Each proximal hand phalanx displays a single, concave proximal (basal) articular facet for the metacarpal head. The proximal thumb phalanx is readily recognizable by its short, stout appearance.

10.3.2 Intermediate Hand Phalanges

Each intermediate hand phalanx displays a double proximal articular facet for the head of the proximal phalanx, and each also has a distal articular facet. The thumb ray bears only two phalanges, lacking a morphologically intermediate phalanx.

10.3.3 Distal Hand Phalanges

Each distal (or terminal) hand phalanx displays a double proximal articular facet for the head of the intermediate phalanx. The terminal end of each has a nonarticular pad, the **distal phalangeal tuberosity** (or **distal tuft**). The thumb phalanx is readily recognizable because of its short, stout appearance. The dorsal surfaces of these phalanges are more rounded, and the palmar surfaces are more rugose.

10.3.4 Growth

Distal hand phalanges are the first hand phalanges to begin ossification (at 7–9 weeks *in utero*), and each has a single primary ossification center, found at the distal tip. Proximal and intermediate hand phalanges each ossify from two centers: a primary one for the shaft and distal end, and a secondary one for the base.

10.3.5 Possible Confusion

Hand phalanges have shafts whose palmar surfaces are flattened, forming a hemicircle in cross section (Figure 10.20). The shafts of foot phalanges are circular in cross section.

10.3.6 Siding

For siding hand and foot phalanges it is best to work with whole specimens and comparative materials, particularly *in vivo* radiographs.

10.3.7 Manual Phalangeal Measurements (Figure 10.21)

1. **Maximum phalangeal length** (Martin, 1928: 1031, #3; Bush et al., 1983: 667, #1): With the sliding caliper kept parallel to the long axis of the phalangeal diaphysis, determine the maximum length of the phalanx.

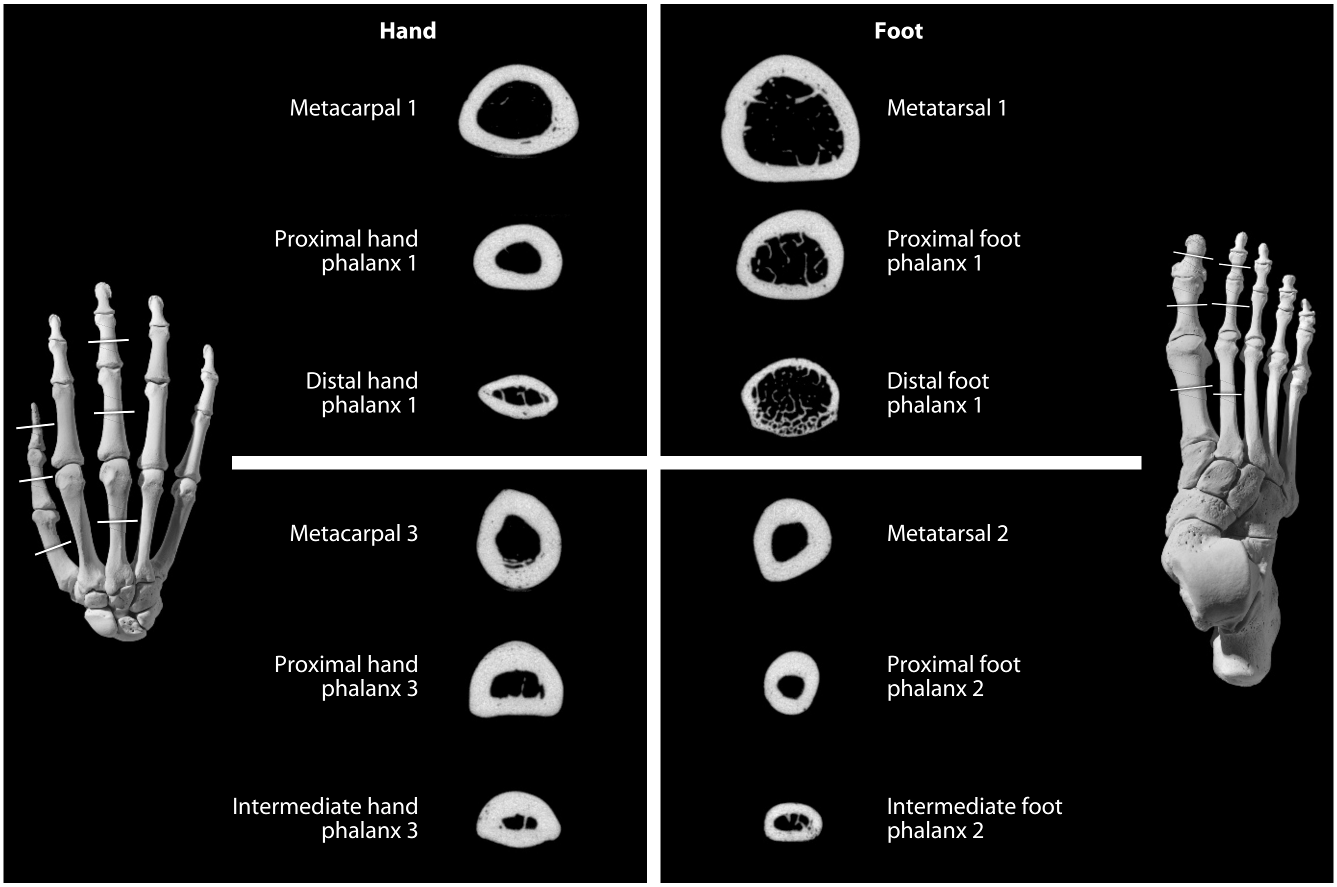

Figure 10.20 **Midshaft CT scans of long bones of the foot and hand compared**. Shafts of foot phalanges and the hallucial metatarsal have rounder cross sections than those of hand phalanges or the thumb metacarpal. The scans were taken from the bones of the individual used to illustrate postcrania in this book. The positions of the CT sections are illustrated on the articulated hand and foot. Dorsal is up and palmar/plantar is down. Natural size.

2. **Phalangeal biomechanical** (or **articular**) **length** (Bush et al., 1983: 667, #2): With a small spreading caliper or a sliding caliper equipped with at least one inside point extension, place the point extension in the depth of the middle of the proximal articular surface and measure the distance to either the proximalmost point on the head of the phalanx (for proximal and intermediate phalanges) or to the distalmost point on the apical tuft (for distal phalanges).
3. **Midshaft anteroposterior** (or **dorsopalmar**) **height** (Bush et al., 1983: 668, #6): First, determine the location at midshaft using 50% of biomechanical length. At this location, use a sliding caliper to measure the greatest dorsopalmar dimension.
4. **Midshaft mediolateral breadth** (Bush et al., 1983: 668, #5): Measuring from the midshaft location (50% of biomechanical length), use a sliding caliper to measure the greatest mediolateral dimension.

10.3.8 Manual Phalangeal Nonmetric Traits

- **Brachydactyly**: Some individuals possess phalanges that are uniformly short relative to other long bones in their bodies, an inherited condition called brachydactyly.

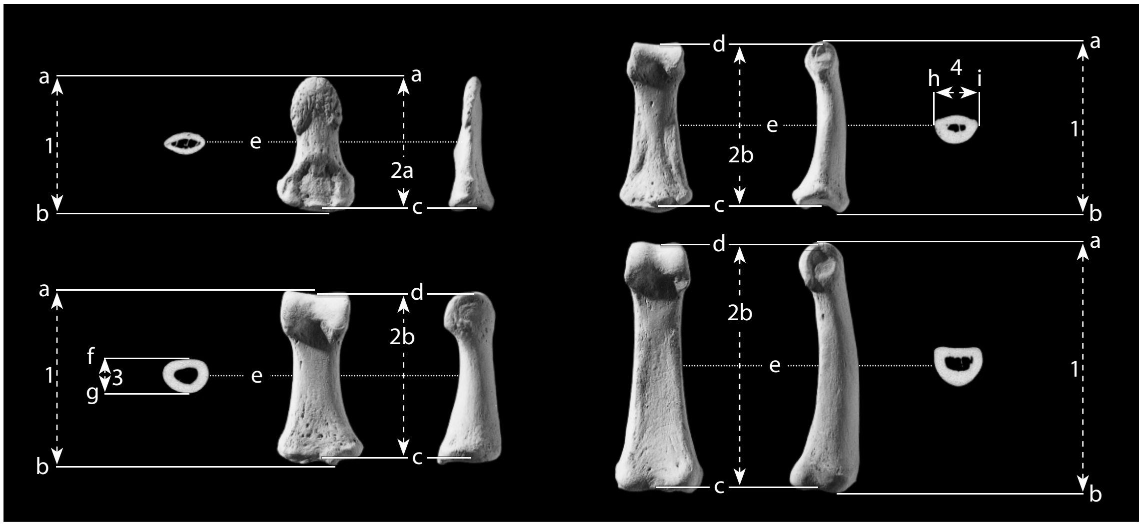

Figure 10.21 **Hand phalangeal measurements.** Phalanges of first and second manual ray. Distal is up for bones; for scans, palmar is up. Two-thirds natural size.

Locations: a) distalmost point on phalanx; b) proximalmost point on phalanx; c) deepest point of proximal articular surface; d) distalmost point of central sulcus of trochlea; e) location of midshaft; f) dorsalmost point of midshaft; g) palmarmost point of midshaft; h) medialmost point of midshaft; i) lateralmost point of midshaft.

Measurements: 1) maximum phalangeal length; 2a) phalangeal biomechanical length (of distal phalanx); 2b) phalangeal biomechanical length (of proximal or intermediate phalanx); 3) phalangeal midshaft height; 4) phalangeal midshaft breadth.

- **Brachymesophalangy**: In some individuals, fingers may be shorter than normal due to reduced length of just the intermediate phalanx, a condition called brachymesophalangy. This condition occurs most commonly on digits 5 and 2, where it is called brachymesophalangy 5 or brachymesophalangy 2.
- **Clubbed thumb**: In some individuals, the distal pollical phalanx is shortened (either bilaterally or asymmetrically) and rounder in distal cross section than normal.

10.4 Functional Aspects of the Hand

Humans have effectively abandoned the use of their forelimbs as supports during locomotion. Primates in general, and humans in particular, have evolved hands that provide the ability for these organisms to manipulate their environment in complex ways. As noted in section 10.1, forearm muscles operate the digits of the hand via tendons that pass across the wrist. The metacarpal heads form foundations from which the thumb and fingers work. The thumb bears only two phalanges, but the saddle-shaped, sellar joint at the base of its metacarpal allows this digit great mobility and the ability to oppose the other digits. Joints between the phalanges are hinge joints whose extension is checked by a palmar ligament, and whose abduction, adduction, and rotation are checked by collateral ligaments.

Most of the force in the grip or extension of the fingers comes from forearm muscles that send tendons across the wrist to insert on the digits. These forearm muscles are called extrinsic hand muscles. As Cartmill et al. (1987) point out, forearm muscles control much of the hand's movement and, in a functional sense, the forearm is best thought of as an appendage of the hand rather than the other way around. Intrinsic muscles of the hand lie within the palm and produce abduction and adduction of the fingers as well as special movements, particularly of the thumb.